

**REMARKS**

This Request for Reconsideration is being filed in response to the Office Action dated September 25, 2003. For the following reasons, this application is in condition for allowance and the case should be passed to issue.

Claims 1-20 are pending in this application. Claims 19 and 20 have been withdrawn pursuant to a restriction requirement. Claims 1-18 have been rejected.

***Claim Rejections Under 35 U.S.C. § 103***

Claims 1-3 and 5 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai (U.S. Patent No. 5,889,331) in view of Applicant admitted prior art (AAPA). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

An aspect of this invention, per claim 1, is a method of manufacturing a semiconductor device comprising providing a silicon-containing substrate having an upper surface. The silicon containing substrate comprises a gate electrode formed on the upper surface of the substrate with a gate insulating layer therebetween. The gate electrode has an upper surface and opposing side surfaces. Source/drain regions are in the substrate spaced apart from the gate electrode. Supersaturated dopant concentration source/drain extensions are formed in the substrate between the source/drain regions and the gate electrode. Metal silicide contacts are formed on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions.

The Examiner asserted that Bai teaches a semiconductor substrate with a gate electrode, source/drain regions, and nickel silicide contact regions formed in a manner sufficient to maintain the dopant concentration in the source/drain extensions. The Examiner acknowledges

that Bai does not disclose the required supersaturated dopant concentration. However, the Examiner asserts that admitted prior art teaches forming supersaturated dopant concentration on the extension to reduce the resistivity of the extensions. Therefore, the Examiner concludes it would have been obvious to recognize that the dopant concentration taught by Bai is supersaturated to provide a method of forming reduced resistivity extensions while maintaining the thickness of the silicide layer.

This rejection should be reconsidered and withdrawn because the Examiner has not presented a *prima facie* case of obviousness. The Examiner has not shown that the use of supersaturated source/drain extensions to reduce resistivity of the extensions is prior art. Contrary to the Examiner's assertion, Applicants have not admitted that forming supersaturated dopant concentration on an extension to reduce resistivity of the extensions is prior art.

Apparently, the Examiner considered Applicants' disclosure on page 1 of the instant specification as admitted prior art. However, there is no admission by Applicants in the instant specification that forming supersaturated dopant concentration on an extension to reduce resistivity of the extensions is prior art. The Examiner is improperly using Applicants' specification against Applicants. 35 U.S.C. § 103(a) statutorily requires that rejections be based on prior art. The Examiner has not based the instant rejection on prior art, as Applicants have not admitted that forming supersaturated dopant concentration on an extension to reduce resistivity of the extension is prior art. This rejection is clearly untenable and should be withdrawn.

Furthermore, Bai and the Examiner alleged AAPA, whether taken alone, or in combination do not suggest the claimed method. The Examiner asserted motivation for combining Bai with the alleged AAPA is unrelated to supersaturated source/drain extensions.

The Examiner asserted motivation is found in Bai. Bai teaches a processes of forming salicides wherein the thickness of the silicide layer of the conductive layer is greater than the thickness of the silicide layer in the diffusion region of a device. Bai is unconcerned with supersaturated source/drain extensions. Neither the silicide layer over the conductive layer or the silicide layer over the diffusion regions of Bai overlies the extensions. It is not seen how the asserted motivation in Bai would suggest to one of skill in this art to form supersaturated source/drain extensions.

Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge readily available to one of ordinary skill in the art. *In re Kotzab*, 217 F.3d 1365, 1370 55 USPQ2d 1313, 1317 (Fed. Cir. 2000); *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). There is no suggestion in Bai or the alleged AAPA to modify the process of Bai to form supersaturated source/drain extensions, as required by claim 1. The mere fact that references can be combined or modified does not render the resulting combination obvious unless the prior art also suggests the desirability of the modification. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

The requisite motivation to support the ultimate legal conclusion of obviousness under 35 U.S.C. § 103 is not an abstract concept, but must stem from the applied prior art as a whole and realistically impel one having ordinary skill in the art to modify a specific reference in a specific manner to arrive at a specifically claimed invention. *In re Deuel*, 51 F.3d 1552, 34 USPQ2d 1210 (Fed. Cir. 1995); *In re Newell*, 891 F.2d 899, 13 USPQ2d 1248 (Fed. Cir. 1989).

Accordingly, the Examiner is charged with the initial burden of identifying a source in the applied prior art for the requisite realistic motivation. *Smiths Industries Medical System v. Vital Signs, Inc.*, 183 F.3d 1347, 51 USPQ2d 1415 (Fed. Cir. 1999); *In re Mayne*, 104 F.3d 1339, 41 USPQ2d 1449 (Fed. Cir. 1997). There is no motivation for modifying the Bai process to form supersaturated source/drain extensions, as required by claim 1.

The only teaching of the claimed method wherein supersaturated dopant concentration source/drain extensions are formed and metal silicide contacts are formed in a manner sufficient to maintain the supersaturated dopant concentration is found in Applicants' disclosure. However, the teaching or suggestion to make a claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicants' disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). As the Examiner acknowledged basing the rejection on Applicants' disclosure, it is clear that the Examiner has relied on impermissible hindsight reasoning. Applicants submit that this rejection should be withdrawn.

Claim 4 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of AAPA and further in view of Hsu (U.S. Patent No. 5,491,099). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that Bai and the alleged AAPA do not disclose removing the spacers prior to forming the source/drain extensions. The Examiner relied on Hsu to provide a teaching of removing spacers prior to forming source/drain extensions and subsequently forming second sidewall spacers. The Examiner concluded that it would have been obvious to combine the teachings of Hsu with Bai and the alleged AAPA to obtain the claimed method in order to reduce the risk of hot electron reliability failures.

The combination of Hsu and Bai and the alleged AAPA does not suggest the claimed method of manufacturing a semiconductor device. Hsu does not cure the deficiencies of Bai and the alleged AAPA. Hsu does not suggest forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by independent claim 1. Hsu teaches away from forming supersaturated source/drain extensions, as Hsu expressly teaches forming lightly doped drains (LDD) that are subsequently exposed to high temperature (column 4, lines 3-14).

A prior art reference must be considered in its entirety, i.e., as a **whole**, including portions that would lead away from the claimed invention. Such a teaching away from a claimed invention constitutes potent evidence of non-obviousness. See, for example, *In re Bell*, 991 F.2d 781, 26 USPQ2d 1529 (Fed. Cir. 1993); *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986); *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984). Hsu teaches forming LDD regions that are subsequently exposed to high temperature. Hence, Hsu teaches away from the claimed method, and it would not be obvious to combine Hsu with Bai to achieve the claimed method.

Furthermore, Hsu discloses first forming the silicide contacts and then subsequently removing the first sidewall spacers (column 3, line 46 to column 4, line 2), whereas claim 4 requires that the silicide contacts are formed **after** the first sidewall spacers are removed.

Claims 6 and 7 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of AAPA and further in view of Murthy et al. (U.S. Patent No. 6,235,568). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that the combination of Bai and the alleged AAPA does not disclose the time and concentration as claimed. The Examiner relied on Murthy et al. to conclude that the time and concentration would have been obvious. The Examiner asserted that one of ordinary skill in this art would have combined the Murthy et al. teaching in order to obtain a high dopant concentration as taught by Bai.

Murthy et al. do not cure the deficiencies of Bai. Murthy et al. teach implanting dopant in the range of approximately  $1 \times 10^{20}$ - $2.5 \times 10^{21}/\text{cm}^3$  in the N-tip regions 212 and in the range of approximately  $1 \times 10^{20}$ - $5 \times 10^{21}/\text{cm}^3$  in the P-tip regions 216 (column 5, lines 3-16 and lines 33-38). Murthy et al., however, teach that the dopant in the N-tip and P-tip regions is diffused out from the implant region when the implants are subsequently annealed (column 5, lines 16-18 and lines 37-40; and column 6, lines 46-53). Thus, Murthy et al. do not maintain supersaturated dopant concentration in the source/drain extensions, as required by claim 1.

The section of Murthy et al. cited by the Examiner as teaching the claimed dopant concentration in the source/drain extensions (column 6, lines 20-30), actually teaches the implanted dopant concentration in the source/drain regions, not the extensions. Further, as explained *supra*, Murthy et al. teach that the dopant is subsequently diffused out from the implant region in an annealing step (column 6, lines 27-29 and lines 46-53). In addition, Murthy et al. teach additional high temperature processing steps of the semiconductor device before the silicide contacts are formed. For example, Murthy et al. disclose forming spacer layer 218 at a temperature of approximately 800 °C (column 5, line 60 to column 6, line 3). Rather than teaching that the dopant concentration is maintained in the source/drain extensions, Murthy et al. **explicitly teach diffusing the dopant** out from the source/drain regions and source/drain

extensions. It is clear that the source/drain extensions in the Murthy et al. device are not supersaturated when the silicide contacts are formed.

Claims 8 and 9 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of AAPA and further in view of Tsukamoto (U.S. Patent No. 5,889,331). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that Bai and the alleged AAPA do not disclose employing laser radiation with the specific energy as claimed. The Examiner relied on Tsukamoto to provide a teaching of pulsed laser irradiation of source/drain regions. The Examiner concluded that it would have been obvious to combine the teachings of Tsukamoto with Murthy et al. to obtain the claimed method in order to reduce leakage current.

The combination of Tsukamoto, Bai, and the alleged AAPA does not suggest the claimed method of manufacturing a semiconductor device. Tsukamoto does not cure the deficiencies of Bai. Tsukamoto does not suggest forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by independent claim 1. Tsukamoto teaches away from forming supersaturated source/drain extensions, as Tsukamoto expressly teaches forming Lightly Doped Drain-source (LDD) that undergo high temperature annealing (column 4, lines 3-11). Furthermore, Tsukamoto teaches exposing the source/drain regions to laser radiation, not the source/drain extensions, as required by claim 8.

A prior art reference must be considered in its entirety, i.e., as a **whole**, including portions that would lead away from the claimed invention. Such a teaching away from a claimed

invention constitutes potent evidence of non-obviousness. See, for example, *In re Bell*, 991 F.2d 781, 26 USPQ2d 1529 (Fed. Cir. 1993); *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986); *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984). Tsukamoto teaches forming LDD regions that undergo high temperature anneal, which would cause dopant to diffuse out from the source/drain extensions. Hence, Tsukamoto teach away from the claimed method, and it would not be obvious to combine Tsukamoto with Bai to achieve the claimed method.

Claims 10 and 11 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai al. in view of AAPA and further in view of Ozturk et al. (U.S. Patent No. 5,242,847). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that Bai and the alleged AAPA does not disclose forming the source/drain extensions by doped selective epitaxy, as claimed. The Examiner relied on Ozturk et al. to provide a teaching of doped selective epitaxy. The Examiner concluded that it would have been obvious to combine the teachings of Ozturk et al. with Bai and the alleged AAPA to obtain the claimed method in order to form doped shallow regions.

The combination of Ozturk et al. and Bai does not suggest the claimed method of manufacturing a semiconductor device. Ozturk et al. do not cure the deficiencies of Bai. Ozturk et al. do not suggest forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by independent claim 1.



Claims 12 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of AAPA and Hsu. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested. The following is a comparison between the invention as claimed and the cited prior art.

An aspect of the present invention, per claim 12, is method of manufacturing a semiconductor device comprising providing a silicon-containing semiconductor substrate and forming a gate oxide layer on the semiconductor substrate. A conductive gate material layer is formed over the gate oxide layer. The gate material layer and gate oxide layer are patterned to form a gate electrode having an upper surface and opposing side surfaces, with a gate oxide layer thereunder. A layer of insulating material is deposited over the gate electrode and semiconductor substrate. The insulating material is patterned to form sidewall spacers on the opposing side surfaces of the gate electrode. Source/drain regions are formed by ion implanting a dopant into the substrate. The sidewall spacers are removed and the substrate is heated to activate the source/drain regions. A supersaturated dopant concentration source/drain extensions are formed between the gate electrode and source/drain regions. A second layer of insulating material is deposited over the gate electrode and semiconductor substrate. The second layer of insulating material is patterned to form sidewall spacers on the opposing side surfaces of the gate electrode. A metal layer is deposited over the gate electrode upper surface, sidewall spacers, and substrate upper surface. The metal layer is heated at a temperature to react with underlying silicon to form metal silicide contacts on the gate electrode and substrate upper surfaces without reducing the dopant concentration in the source/drain extensions below a supersaturated dopant concentration. The metal that did not react to form metal silicide is removed.

The Examiner acknowledged that Bai does not disclose removing the spacers prior to forming the source/drain extensions. The Examiner relied on Hsu to provide a teaching of removing spacers prior to forming source/drain extensions and subsequently forming second sidewall spacers. The Examiner concluded that it would have been obvious to combine the teachings of Hsu with Bai to obtain the claimed method in order to reduce the risk of hot electron reliability failures.

The combination of Hsu and Bai does not suggest the claimed method of manufacturing a semiconductor device. Hsu does not cure the deficiencies of Bai. Hsu does not suggest forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by independent claim 12. Hsu teaches away from forming supersaturated source/drain extensions, as Hsu expressly teaches forming lightly doped drains (LDD) that are subsequently exposed to high temperature (column 4, lines 3-14).

A prior art reference must be considered in its entirety, i.e., as a **whole**, including portions that would lead away from the claimed invention. Such a teaching away from a claimed invention constitutes potent evidence of non-obviousness. Hsu teaches forming LDD regions that are subsequently exposed to high temperature. Hence, Hsu teaches away from the claimed method, and it would not be obvious to combine Hsu with Bai to achieve the claimed method.

Furthermore, Hsu discloses first forming the silicide contacts and then subsequently removing the first sidewall spacers (column 3, line 46 to column 4, line 2), whereas claim 12 require that the silicide contacts are formed **after** the first sidewall spacers are removed.

Claims 14 and 15 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai, AAPA prior art and Hsu and further in view of Ozturk et al. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

As discussed *supra*, Hsu and Ozturk et al. do not cure the deficiencies of Bai, thus the combination of Ozturk et al. with Bai and Hsu does not suggest the claimed invention.

Claims 16 and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai, AAPA and Hsu and further in view of Tsukamoto et al. (U.S. Patent No. 5,399,506). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

As discussed *supra*, Hsu and Tsukamoto do not cure the deficiencies of Bai, thus the combination of Tsukamoto with Bai and Hsu does not suggest the claimed invention.

Claim 18 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai, AAPA and Hsu and further in view of Murthy et al. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

As discussed *supra*, Hsu and Murthy et al. do not cure the deficiencies of Bai, thus the combination of Murthy et al. with Bai and Hsu does not suggest the claimed invention.

In light of the remarks above, this application is in condition for allowance, and the case should be passed to issue. If there are any questions regarding this Request for Reconsideration or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

10/071,207

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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